

4, August 1986). Claims 1-6 were rejected under 35 U.S.C. §103(a) as being obvious over Persistence of Vision®'s Ray-Tracer software ("POV-Ray", 1997) in view of *Penna* (U.S. Patent No. 5,905,503). The above rejection is respectfully traversed based on the remarks that follow.

The present invention and the POV-Ray reference have been discussed at length in Applicant's prior Responses, and need not be repeated. The instant Office Action acknowledges that POV-Ray fails to "disclose approximating an illumination effect of each of the finite light sources by the use of a single point light source of varying intensity and location, taking into account the finite size and center of each of the finite light sources." Because of this deficiency, the Office Action also relies on *Penna*.

*Penna* is directed to a 3-D image synthesis apparatus that uses a look-up table to estimate the illumination of a point on the object surface ( $P_o$ ), as shown in Fig. 2. The directionality of the illumination of the finite light source (LS) is stored in the look-up table (606, Fig. 6) and indexed according to angles ( $\phi, \theta$ ) between the surface normal of the finite light source, ( $\underline{N}_L$ ), and a vector  $\underline{L}$  between the point  $P_o$  and  $P_L$ , the light source position, as shown in Fig. 3. As shown in Fig. 6, a polar coordinate calculator (608) is used to determine the direction between  $P_o$  and  $P_L$  and then scaled in accordance with an inverse-square law (610) to provide an illumination intensity value  $ILL$  for the object point  $P_o$ .

Thus, the disclosure of *Penna* does not comport with its description in the Office Action. The Office Action alleges that  $P_o$ , in Fig. 2, is "a single light source of varying intensity." *Penna* clearly provides that  $P_o$  is a point "on an object surface  $O$  in the 3-D

object space" (column 4, lines 64-65), not a light source. Rather,  $P_o$  is a particular point on the surface, where the illuminations of a myriad of points on the object are determined to obtain the two-dimensional image. *Penna* provides for a finite light source, designated by its position  $P_L$ , and approximates the illumination effect on the point  $P_o$  through the look-up table and distance scaling.

Applicant also notes that *Penna* deals with the surface point,  $P_o$ , the light source direction,  $NI$ , and the light direction impinging on the surface,  $L$ . As such, *Penna* encodes in a lookup table information about the shape of the light distribution in the scene, and using the above information, quickly determines the light intensity at the surface. Since *Penna* is using  $P_o$ ,  $NI$ , and  $L$  as the variables in the system, the light variation it produces can **only** encompass the effect the surface location ( $P_o$ ) relative to the light source has on the light intensity at the surface.

This can be contrasted with the methods of the present invention, which deals with the effect the surface orientation,  $N_o$  in *Penna*, has on the illumination of the surface point  $P_o$  due to the occlusion of the light source by the object's surface. So while *Penna* answers the question of how much light could reach the surface point  $P_o$  from the light source, it has no means of further determining how much of that light will be occluded from the surface point due to the surface's orientation,  $N_o$ , relative to the light source.

Thus, while *Penna* describes a means of quickly determining the distribution of light within a scene based on encoding that information within a lookup table, the present invention is concerned with the degree to which that light is modified by the occlusion of the light source by the surface. While the former problem, other than for

the purposes of interactively rendering a 3D scene, has many solutions and methods of implementing those solutions, the latter, until the methods of the present invention, has not had any simple or quickly computable means of solution. The problem *Penna* addresses, therefore, is an entirely separate and orthogonal issue to the one addressed by the present invention.

This is further illustrated in claim 1, that provides that the illumination effect for each of the finite light sources is approximated "by the use of a single point light source of varying intensity and location." The present invention uses a point light source in place of the finite light source and compensates for the difference by setting the location and intensity to achieve the approximate illumination effect. *Penna* does not discuss the use of point light sources, except in the description of the related art, where the term is used to distinguish point light sources from finite light sources.

As such, Applicant respectfully asserts that *Penna* fails to teach or suggest what the Office Action alleges. Additionally, even when taken together with the POV-Ray reference, the combination of POV-Ray and *Penna* fails to teach or suggest the present invention as claimed in claims 1-6.

As discussed above, the Office has acknowledged that POV-Ray fails to teach approximating the illumination effects of a finite light source by the use of a single point light source. Even with the discussion of point light sources in POV-Ray, one of ordinary skill in the art would not have been motivated to employ point light sources in *Penna*, because *Penna* has a very different system for approximating illumination effects that do not require the use of point light sources of varying intensity and location. There is no suggestion in *Penna* of approximating the finite light source by point light

sources, even though such point light sources were known and were discussed in *Penna*. Thus, the combination fails to teach or suggest “approximating an illumination effect of each of the finite light sources by the use of a single point light source of varying intensity and location, taking into account the finite size and shape of each of the finite light sources.” As such, Applicant respectfully asserts that the rejection is improper for failing to teach all of the elements of claims 1-6. Reconsideration is respectfully requested.

In addition, the rejection fails to consider or overcome the indicia of nonobviousness provided in the specification and discussed in Applicant’s previous responses. When evidence of any secondary considerations is submitted, the Examiner must evaluate the evidence. M.P.E.P. 2141.

The rejection alleges, in effect, that the POV-Ray software, coupled with *Penna*, can approximate the effect of any type of area light source and that such approximation is an obvious extension of *Penna*, POV-Ray or both. However, if such an extension were obvious, it would be in widespread use throughout the industry. This is due to the fact that the cost of implementing a spherical pseudo area light is virtually nil, and the effect is much more realistic illumination. The pursuit of realism and lower computational cost are the two dominant driving forces in the industry. The fact that such an implementation, which addresses both these goals, does not exist is a clear demonstration that such an extension is not obvious.

In addition, even if the references were somehow combined, they would not reduce computation time nor cost. As discussed previously, the POV-Ray software teaches away from efficiency and instead emphasizes photo-realistic results. The

combination of references cited in the rejection would not provide the benefits of the present invention. The Examiner is respectfully requested to consider the above noted benefits in reconsidering the prior rejections.

As such, Applicant respectfully asserts that the rejection of claims 1-6 is improper and should be withdrawn. Applicant also respectfully requests that the application be allowed to proceed to issue. If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the Applicant's undersigned attorney at the indicated telephone to arrange for an interview to expedite this position of this application.

In the event this paper is not being timely filed, the Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to counsel's Deposit Account No. 01-2300.

Respectfully submitted,

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